

23. Identify the answers to these exercises using consistent units.

- a. Find the area of a rectangle 2 mm by 30 cm.

$$A = (0.2 \text{ cm})(30 \text{ cm}) = 6 \text{ cm}^2$$

- b. Find the perimeter of a rectangle 25 cm by 2.00 m.

$$P = 0.25 \text{ m} + 0.25 \text{ m} + 2.00 \text{ m} + 2.00 \text{ m} = 4.50 \text{ m}$$

24. Find which of the following equations are incorrect.

- a. $\text{area} = (\text{length})(\text{width})(\text{height})$

incorrect; area has units m^2 and $(\text{length})(\text{width})(\text{height})$ has units m^3

- b. $\text{time} = \frac{\text{distance}}{\text{speed}}$

correct since $\frac{\text{distance}}{\text{speed}}$ has units $\frac{m}{(m/s)} = s$

- c. $\text{distance} = (\text{speed})(\text{time})^2$

incorrect since $(\text{speed})(\text{time})^2$ has units $(m/s)(s)^2 = m \cdot s$

Chapter Review Problems

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1. Express the following numbers in scientific notation.

- a. 5 000 000 000 000 000 000 000 000 m

$$5 \times 10^{24} \text{ m}$$

- b. 0.000 000 000 000 000 000 166 m

$$1.66 \times 10^{-19} \text{ m}$$

- c. 2 033 000 000 m

$$2.033 \times 10^9 \text{ m}$$

- d. 0.000 000 103 0 m

$$1.030 \times 10^{-7} \text{ m}$$

2. Convert each of the following measurements into meters.

- a. 42.3 cm

$$\frac{42.3 \text{ cm}}{1} \left[\frac{1 \times 10^{-2} \text{ m}}{1 \text{ cm}} \right] = 0.423 \text{ m}$$

- b. 6.2 pm

$$\frac{6.2 \text{ pm}}{1} \left[\frac{1 \times 10^{-12} \text{ m}}{1 \text{ pm}} \right] = 6.2 \times 10^{-12} \text{ m}$$

- c. 21 km

$$\frac{21 \text{ km}}{1} \left[\frac{1 \times 10^3 \text{ m}}{1 \text{ km}} \right] = 2.1 \times 10^4 \text{ m}$$

- d. 0.023 mm

$$\frac{0.023 \text{ mm}}{1} \left[\frac{1 \times 10^{-3} \text{ m}}{1 \text{ mm}} \right] = 2.3 \times 10^{-5} \text{ m}$$

- e. 214 μm

$$\frac{214 \mu\text{m}}{1} \left[\frac{1 \times 10^{-6} \text{ m}}{1 \mu\text{m}} \right] = 2.14 \times 10^{-4} \text{ m}$$

- f. 570 nm

$$570 \text{ nm} \left[\frac{1 \times 10^{-9} \text{ m}}{1 \text{ nm}} \right] = 5.70 \times 10^{-7} \text{ m}$$

3. Rank the following mass measurements from smallest to largest: 11.6 mg, 1021 μg , 0.000 006 kg, 0.31 mg.

$$\frac{11 \text{ mg}}{1} \left[\frac{1 \times 10^{-3} \text{ g}}{1 \text{ mg}} \right] = 1.1 \times 10^{-2} \text{ g}$$

$$\frac{1021 \mu\text{g}}{1} \left[\frac{1 \times 10^{-6} \text{ g}}{1 \mu\text{g}} \right] = 1.021 \times 10^{-3} \text{ g}$$

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$$\frac{0.000\,006\text{ kg}}{1} \left[\frac{10^3\text{ g}}{1\text{ ky}} \right] = 6 \times 10^{-3}\text{ g}$$

$$\frac{0.31\text{ mg}}{1} \left[\frac{1 \times 10^{-7}\text{ g}}{1\text{ mg}} \right] = 3.1 \times 10^{-4}\text{ g}$$

0.31 mg, 1021 μg , 0.000 006 kg, 11 mg

4. Add or subtract as indicated.

a. $5.80 \times 10^9\text{ s} + 3.20 \times 10^9\text{ s}$

$$5.80 \times 10^9\text{ s} + 3.20 \times 10^9\text{ s} = 6.12 \times 10^9\text{ s}$$

b. $4.87 \times 10^{-6}\text{ m} - 1.93 \times 10^{-6}\text{ m}$

$$4.87 \times 10^{-6}\text{ m} - 1.93 \times 10^{-6}\text{ m} = 2.94 \times 10^{-6}\text{ m}$$

c. $3.14 \times 10^{-5}\text{ kg} + 9.36 \times 10^{-5}\text{ kg}$

$$3.14 \times 10^{-5}\text{ kg} + 9.36 \times 10^{-5}\text{ kg} = 12.50 \times 10^{-5}\text{ kg} = 1.250 \times 10^{-4}\text{ kg}$$

d. $8.12 \times 10^7\text{ g} - 6.20 \times 10^6\text{ g}$

$$8.12 \times 10^7\text{ g} - 6.20 \times 10^6\text{ g} = 7.50 \times 10^7\text{ g}$$

5. State the number of significant digits in each measurement.

a. 248 m 3

b. 0.000 03 m 1

c. 64.01 m 4

d. 80.001 m 5

6. State the number of significant digits in the following measurements.

a. $2.40 \times 10^6\text{ kg}$ 3

b. $6 \times 10^8\text{ kg}$ 1

c. $4.07 \times 10^{16}\text{ m}$ 3

Chapter Review Problems

7. Many labels give metric equivalents of English quantities. Examples are: 12 fluid ounces (9345.66 mL), 353 ft (107.59 m), 2.0 inches (50.80 mm). Report each metric equivalent using the correct number of significant digits.

$9.3 \times 10^3\text{ mL}$, 108 m, 51 mm

8. Add or subtract as indicated and state the answer with the correct number of significant digits.

a. $16.2\text{ m} + 5.008\text{ m} + 13.48\text{ m}$

$$\begin{array}{r} 16.2\text{ m} \\ 5.008\text{ m} \\ \underline{13.48\text{ m}} \\ 34.688\text{ m} = 34.7\text{ m} \end{array}$$

b. $5.006\text{ m} + 12.0077\text{ m} + 8.0084\text{ m}$

$$\begin{array}{r} 5.006\text{ m} \\ 12.0077\text{ m} \\ \underline{8.0084\text{ m}} \\ 25.0221\text{ m} = 25.022\text{ m} \end{array}$$

c. $78.05\text{ cm}^2 - 32.046\text{ cm}^2$

$$\begin{array}{r} 78.05\text{ cm}^2 \\ \underline{-32.046\text{ cm}^2} \\ 46.004\text{ cm}^2 = 46.00\text{ cm}^2 \end{array}$$

d. $15.07\text{ kg} - 12.0\text{ kg}$

$$\begin{array}{r} 15.07\text{ kg} \\ \underline{-12.0\text{ kg}} \\ 3.07\text{ kg} = 3.1\text{ kg} \end{array}$$

9. Multiply or divide as indicated watchin significant digits.

a. $(6.2 \times 10^{18}\text{ m})(4.7 \times 10^{-10}\text{ m})$

$$2.9 \times 10^9\text{ m}^2$$

b. $(5.6 \times 10^{-7}\text{ m}) + (2.8 \times 10^{-12}\text{ m})$

$$2.0 \times 10^5\text{ m/s}$$

c. $(8.1 \times 10^{-4}\text{ km})(1.6 \times 10^4\text{ km})$

$$1.3 \times 10^{-6}\text{ km}^2$$



d. $(6.5 \times 10^5 \text{ kg}) + (3.4 \times 10^3 \text{ m}^3)$

$1.9 \times 10^2 \text{ kg/m}^3$

10. Tom did the following problems on his calculator, reporting results shown. Give the answer to each using the correct number of significant digits.

a. $5.32 \text{ mm} + 2.1 \text{ mm} = 7.4200000 \text{ mm}$

7.4 mm

b. $13.597 \text{ m} \times 3.65 \text{ m} = 49.6290500 \text{ m}^2$

49.6 m^2

c. $83.2 \text{ kg} - 12.804 \text{ kg} = 70.3960000 \text{ kg}$

70.4 kg

11. A rectangular floor has a length of 15.72 m and a width of 4.40 m. Calculate the area of the floor to the best possible value using these measurements.

69.2 m^2

12. A yard is 33.21 m long and 17.6 m wide.

a. What length of fence must be purchased to enclose the entire yard?

$$\begin{aligned} \text{Perimeter} &= 2\ell + 2w \\ &= 2(33.21 \text{ m}) + 2(17.6 \text{ m}) \\ &= 66.42 \text{ m} + 35.2 \text{ m} \\ &= 101.6 \text{ m} \end{aligned}$$

b. What area must be covered if the yard is to be fertilized?

$$\begin{aligned} \text{Area} &= \ell w = (33.21 \text{ m})(17.6 \text{ m}) \\ &= 584 \text{ m}^2 \end{aligned}$$

13. The length of a room is 16.40 m, its width is 4.5 m, and its height is 3.26 m. What volume does the room enclose?

$$\begin{aligned} V &= \ell wh = (16.40 \text{ m})(4.5 \text{ m})(3.26 \text{ m}) \\ &= 2.4 \times 10^2 \text{ m}^3 \end{aligned}$$

14. The sides of a quadrangular plot of land are 132.68 m, 48.3 m, 132.736 m, and 48.37 m. What is the perimeter of the plot, as can best be determined from these measurements?

$$\begin{aligned} \text{Perimeter} &= 132.68 \text{ m} + 48.3 \text{ m} + 132.736 \text{ m} + 48.37 \text{ m} \\ &= 362.1 \text{ m} \end{aligned}$$

15. A water tank has a mass of 3.64 kg when empty and a mass of 51.8 kg when filled to a certain level. What is the mass of the water in the tank?

$$\begin{aligned} &51.8 \text{ kg} \\ &\underline{-3.64 \text{ kg}} \\ &48.16 \text{ kg} = 48.2 \text{ kg} \end{aligned}$$

16. Figure 2-18 shows the mass of three substances for volumes between 0 and 60 cm³.

a. What is the mass of 30 cm³ of each substance?

(a) 80 g, (b) 260 g, (c) 400 g.

b. If you had 100 g of each substance, what would their volumes be?

(a) 37 cm³, (b) 11 cm³, (c) 7 cm³.

c. Describe the meaning of the steepness of the lines in this graph (a single word is not a sufficient answer!).

The steepness represents the increased mass of each additional cubic centimeter of the substance.

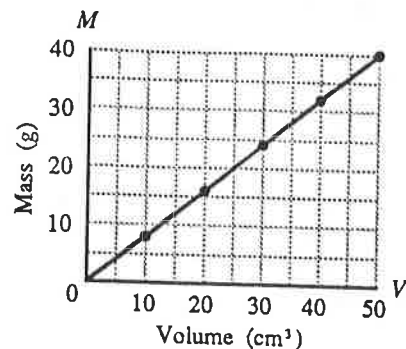
17. During an experiment, a student measured the mass of 10.0 cm³ of alcohol. The student then measured the mass of 20.0 cm³ of alcohol. In this way the data in Table 2-3 were collected.

Table 2-3

Volume (cm ³)	Mass (g)
10.0	7.9
20.0	15.8
30.0	23.7
40.0	31.6
50.0	39.6

Chapter Review Problems

- a. Plot the values given in the table and draw the curve that best fits all points.



- b. Describe the resulting curve.

A straight line

- c. Use the graph to write an equation relating the volume to the mass of the alcohol.

$M = mV$, where m is the slope

- d. Find the units of the slope of the graph. What is the name given to this quantity?

mass/volume; density

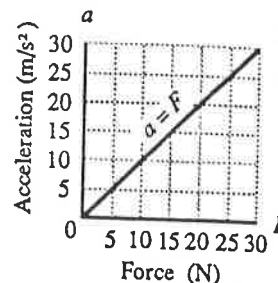
18. During a class demonstration, an instructor placed a 1.0-kg mass on a horizontal table that was nearly frictionless. The instructor then applied various horizontal forces to the mass and measured the rate at which the mass gained speed (was accelerated) for each force applied. The results of the experiment are shown in Table 2-4.

Table 2-4

Force (N)	Acceleration (m/s²)
5.0	4.9
10.0	9.8
15.0	15.2
20.0	20.1
25.0	25.0
30.0	29.9

Chapter Review Problems

- a. Plot the values given in the table the curve that best fits all points.



- b. Describe, in words, the relationship between force and acceleration according to graph.

The acceleration varies directly with force

- c. Write the equation relating the force and acceleration that results from the graph.

$$F = ka$$

- d. Find the units of the slope of the graph.

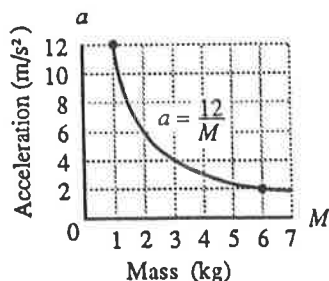
$$k = a/F \text{ so the units of } k \text{ are } (\text{m/s}^2)/\text{N} = \text{m/s}^2 \cdot \text{N}$$

19. The teacher who performed the experiment the previous problem then changed procedure. The mass was varied while force was kept constant. The acceleration each mass was then recorded. The results shown in Table 2-5.

Table 2-5

Mass (kg)	Acceleration (m/s²)
1.0	12.0
2.0	5.9
3.0	4.1
4.0	3.0
5.0	2.5
6.0	2.0

- a. Plot the values given in the table and draw the curve that best fits all points.



- b. Describe the resulting curve.

Hyperbola

- c. According to the graph, what is the relationship between mass and the acceleration produced by a constant force?

Acceleration varies inversely with the mass.

- d. Write the equation relating acceleration to mass given by the data in the graph.

$$a = c/M, c = \text{constant} = 12$$

- e. Find the units of the constant in the equation.

$$c = Ma, \text{ so the units of } c \text{ are } (\text{kg})(\text{m/s}^2) \\ = \text{kg} \cdot \text{m/s}^2$$

20. Each cubic centimeter of gold has a mass of 19.3 g. A cube of gold measures 4.23 cm on each edge.

- a. What is the volume of the cube?

$$(4.23 \text{ cm})^3 = 75.7 \text{ cm}^3$$

- b. What is its mass?

$$M = (\text{density})(V) = (19.3 \text{ g/cm}^3)(75.7 \text{ cm}^3) \\ = 1.46 \times 10^3 \text{ g}$$

21. Solve the equation

$$T = 2\pi\sqrt{\frac{\ell}{g}}$$

for

- a. ℓ

$$T = 2\pi\sqrt{\frac{\ell}{g}}, \text{ so } \frac{T}{2\pi} = \sqrt{\frac{\ell}{g}} \text{ square both sides}$$

$$\frac{T^2}{4\pi^2} = \frac{\ell}{g}, \text{ so } \ell = \frac{gT^2}{4\pi^2}$$

- b. g

$$\text{from above } - \frac{T^2}{4\pi^2} = \frac{\ell}{g}, \text{ so } \frac{gT^2}{4\pi^2} = \ell,$$

$$\text{or } gT^2 = 4\pi^2\ell, \text{ or } g = \frac{4\pi^2\ell}{T^2}$$

22. Each cubic centimeter of silver has a mass of 10.5 g.

- a. What is the mass of 65.0 cm³ of silver?

$$\text{density of silver} = D = 10.5 \text{ g/cm}^3. \\ \text{Since } D = M/V, \\ M = DV = (10.5 \text{ g/cm}^3)(65.0 \text{ cm}^3) \\ = 683 \text{ g}$$

- b. When placed on a beam balance, the 65.0 cm³ piece of silver has a mass of only 616 g. What volume of the piece is hollow?

$$\text{actual volume of silver} \\ = V = M/D = (616 \text{ g})/(10.5 \text{ g/cm}^3) \\ = 58.7 \text{ cm}^3. \\ \text{Hollow volume} = \text{given volume} - \text{actual volume} \\ = 65.0 \text{ cm}^3 - 58.7 \text{ cm}^3 = 6.3 \text{ cm}^3$$

23. Assume that a small sugar cube has sides 1.0 cm long. If you had a box containing 1 mole of sugar cubes and lined them up side by side, how long would the line be? 1 mole = 6.02×10^{23} units.

$$(6.02 \times 10^{23})(1 \text{ cm}) = 6.02 \times 10^{23} \text{ cm or} \\ (6.02 \times 10^{23} \text{ cm}) / (100 \text{ cm/m})(1000 \text{ m/km}) \\ = 6.02 \times 10^{18} \text{ km}$$

24. The average distance between Earth and the sun is 1.50×10^8 km.

- a. Calculate the average speed, in km/h, of Earth assuming a circular path about the sun. Use the equation $v = \frac{2\pi r}{t}$.

$$v = \frac{2\pi r}{t} = \frac{2\pi(1.50 \times 10^8 \text{ km})}{365 \text{ dy} \left[\frac{24 \text{ h}}{1 \text{ dy}} \right]}$$

$$= 1.08 \times 10^5 \text{ km/h}$$

- b. Convert your answer from km/h to m/s. Show all units.

$$\frac{1.08 \times 10^5 \text{ km}}{\text{h}} \left[\frac{1000 \text{ m}}{1 \text{ km}} \right] \left[\frac{1 \text{ h}}{3600 \text{ s}} \right]$$

$$= 3.00 \times 10^4 \text{ m/s}$$

25. The radius of Earth is 6.37×10^3 km.

- a. Find the speed, in km/h, resulting from the rotation of Earth, of a person standing on the equator.

$$v = \frac{2\pi r}{t} = \frac{2\pi(6.37 \times 10^3 \text{ km})}{24 \text{ h}}$$

$$= 1.67 \times 10^3 \text{ km/h}$$

- b. Convert your answer to m/s.

$$\frac{1.67 \times 10^3 \text{ km}}{\text{h}} \left[\frac{1 \text{ h}}{3600 \text{ s}} \right] \left[\frac{1000 \text{ m}}{1 \text{ km}} \right]$$

$$= 464 \text{ m/s}$$

Chapter Review Problems

26. A child rides a merry-go-round horse that is 5.4 m from the center. The ride lasts 10 minutes. During this time the ride makes 24 revolutions. Find the speed of the child in meters/second. Use the equation $v = \frac{2\pi r}{t}$.

$$t = \frac{10 \text{ min}}{24 \text{ rev}} = 0.42 \frac{\text{min}}{\text{rev}}, \text{ and}$$

$$v = \frac{2\pi r}{t} = \frac{2\pi(5.4 \text{ m})}{\left[\frac{0.42 \text{ min}}{1} \right] \left[\frac{60 \text{ s}}{1 \text{ min}} \right]} = 1.4 \text{ m/s}$$

27. Manipulate the equation $v = d/t$ and find the answers to these problems using consistent units.

- a. Find the distance a bike travels in 1.5 minutes, if it is traveling at a constant speed of 20 km/hr.

$$v = \frac{d}{t},$$

$$\text{so } d = vt = \left[\frac{20 \text{ km}}{\text{h}} \right] \left[\frac{1 \text{ h}}{60 \text{ min}} \right] \left[\frac{1.5 \text{ min}}{1} \right] \\ = 0.50 \text{ km}$$

- b. How long would it take a car to travel 6000 m if its speed is a constant 30 km/hr?

$$v = \frac{d}{t}, \text{ so } vt = d, \text{ and } t = \frac{d}{v}$$

$$= \frac{\left[\frac{6000 \text{ m}}{1} \right] \left[\frac{1 \text{ km}}{1000 \text{ m}} \right]}{30 \frac{\text{km}}{\text{h}}} = 0.20 \text{ h}$$

28. Water drips from a faucet into a flask at rate of two drops every 3 seconds. A centimeter (cm^3) contains 20 drops. What volume of water, in cubic decimeters (dm^3), will be collected in 1 hour?

$$V = \left[\frac{2 \text{ drops}}{30 \text{ s}} \right] \left[\frac{1 \text{ cm}^3}{20 \text{ drops}} \right] \left[\frac{\text{dm}^3}{1000 \text{ c}} \right]$$

$$= \left[\frac{3600 \text{ s}}{1 \text{ h}} \right] = 0.12 \frac{\text{dm}^3}{\text{h}}$$

29. Tony's Pizza Shop ordered new 23 cm pizza pans (9-inch pans). By mistake, 26 cm (10-inch) pans were delivered. Tony says that the difference is too small to worry about. As Tony's accountant, what would you say knowing materials cost about 0.25 cents per square centimeter?

The area of each pan is given by $A = \pi r^2$ or $\pi \left(\frac{d}{2}\right)^2$, so the difference in area for the pans is

$$\pi \left(\frac{26 \text{ cm}}{2}\right)^2 - \pi \left(\frac{23 \text{ cm}}{2}\right)^2 = 120 \text{ cm}^2$$

$(120 \text{ cm}^2)(0.25\text{¢}/\text{cm}^2) = \0.30
Each pizza costs 30 cents more.

Supplemental Problems

1. Express the following numbers in scientific notation.

- a. 810 000 g $8.1 \times 10^5 \text{ g}$
- b. 0.000634 g $6.34 \times 10^{-4} \text{ g}$
- c. 60 000 000 g $6 \times 10^7 \text{ g}$
- d. 0.0000010 g $1.0 \times 10^{-6} \text{ g}$

2. Convert each of the following time measurements to its equivalent in seconds.

- a. 58 ns $5.8 \times 10^{-8} \text{ s}$
- b. 0.046 Gs $4.6 \times 10^7 \text{ s}$
- c. 9270 ms 9.27 s
- d. 12.3 ks $1.23 \times 10^4 \text{ s}$

3. Solve the following problems. Express your answers in scientific notation.

- a. $6.2 \times 10^{-4} \text{ m} + 5.7 \times 10^{-3}$
 $6.32 \times 10^{-3} \text{ m}$
- b. $8.7 \times 10^8 \text{ km} - 3.4 \times 10^7 \text{ km}$
 $8.36 \times 10^8 \text{ km}$
- c. $(9.21 \times 10^{-5} \text{ cm})(1.83 \times 10^8 \text{ cm})$
 $1.69 \times 10^4 \text{ cm}^2$
- d. $(2.63 \times 10^{-6} \text{ m}) + (4.08 \times 10^6 \text{ s})$
 $6.45 \times 10^{-13} \text{ m/s}$

4. State the number of significant digits in the following measurements.

- a. 3218 kg 4
- b. 60.080 kg 5
- c. 801 kg 3
- d. 0.000534 kg 3

5. State the number of significant digits in the following measurements.

- a. $5.60 \times 10^8 \text{ m}$ 3
- b. $3.0005 \times 10^{-6} \text{ m}$ 5
- c. $8.0 \times 10^{10} \text{ m}$ 2
- d. $9.204 \times 10^{-3} \text{ m}$ 4

